

Profile of Contact Dermatitis in Elderly Patients

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Abstract

Background: Contact dermatitis (CD) is one of the most common inflammatory skin disorders. Decreased skin function in the elderly, such as decreased collagen synthesis, hydration, and sebum production that causes dry skin and changes in immunological responses, are risk factors for CD in the elderly.

Objective: To determine the profile of contact dermatitis in the elderly.

Methods: This study is a descriptive retrospective study conducted at the Dermatology and Venereology outpatient unit of Dr. Soetomo General Academic Hospital Surabaya, with a population of contact dermatitis patients aged 50 years or older, using total sampling methods in a 3-year period.

Results: The number of elderly patients was 9,063 out of 32,226 patients (0.28%) at the Dermatology and Venereology outpatient unit of Dr. Soetomo General Academic Hospital Surabaya for 3 years (2019-2022). Out of the 9,063 elderly patients, there were 90 elderly CD patients (0.90%), representing 18.33% of the total 491 CD patients, consisting of allergic contact dermatitis (53.3%) and irritant contact dermatitis (46.7%), with an age range of 50-90 years (mean 61.1±7.9). The most causative agents in ACD were cosmetics (40.1%) and medicated oils (33.3%), while in ICD were herbal oils (25.9%), detergents (22.4%), and dishwashing soap (18.9%).

Conclusion: The prevalence of CD among the elderly for a period of 3 years was 18.33% out of patients diagnosed with CD. Females, aged 55 to 65 years, and working as housewives made up the majority of elderly CD patients, with hand and face dermatitis as the most common manifestation.

Keywords: Contact dermatitis, epidemiology, elderly, human and health.

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Introduction

Contact dermatitis (CD) is one of the most common inflammatory skin disorders that happen due to external agents' exposure.¹ The two major types of contact dermatitis are: allergic contact dermatitis, characterized by a type IV-mediated hypersensitivity to a particular allergen that penetrates the skin, and irritant contact dermatitis, which occurs without specific immunological mediation.¹

In Japan, 3.92% of 170 clinic patients were affected by CD with a wide age distribution.² The CD ranked as the third most frequent skin disorder in Europe and fifth in the United States. In Europe, the prevalence of CD is 15%, with the highest rates in populations aged 35-50 years. There is a high prevalence of CD among the elderly, with 63.7% of 600 elderly patients diagnosed with CD.³ Collagen synthesis, hydration, lipid, and sebum production

decreased with age, causing skin dryness and immunological response issues. Two-thirds of elderly individuals who developed xerosis cutis experience chronic pruritus, where dry skin is one of the predisposing factors for CD in elderly population.^{2,3,4}

In general, CD usually presents with itch, burning sensations, redness, papules, edema, vesicular, and oozing, mainly localized to the site of exposure; diffuse manifestations may also occur. Various studies investigate the common agents causing CD, identifying the most prevalent allergens as metals (nickel, mercury, palladium), rubber, hair dye, fragrance mix, and topical agents (balsam, paraben mix, medication). Dry air, hot water, cleansing agents, and mechanical stress often trigger irritant contact dermatitis (ICD). The increased prevalence of incontinence in elderly patients is associated with perineal incontinence-associated contact dermatitis resulting from ammonia (urine) and proteases from faecal enzymes, which lead to the lysis of stratum corneum (SC) proteins and lipids.^{2,3}

Although CD is not classified as a life-threatening condition, a decrease in health-related quality of life (HRQoL) is closely related with the intensity and duration of the symptoms, particularly pruritus (itching). Chronic pruritus can lead to difficulties in work and impact sleep disturbances which result in anxiety and depression. This condition is a common reason for dermatological consultations among the elderly.⁵ Since there is a limited amount of data concerning the prevalence and characteristics of CD in the elderly population, particularly in Indonesia, our objective is to provide the epidemiological profile to optimize the management in elderly CD patients.

Methods

Study Design and Participants

A descriptive retrospective study was carried out at the Dermatology and Venereology outpatient unit of Dr. Soetomo General Academic Hospital in Surabaya. The study population consisted of elderly patients aged 50 years and older, regardless of gender, diagnosed with contact dermatitis and

fulfilled the inclusion criteria (with complete medical records), from 2019 to 2021. The sample size in this study was determined using the total sampling method.

Data Collection

This study gathered all the data from the medical records of the hospital's database. These variables included age, sex, occupation, clinical findings (chief complaints, duration of illness, and affected body areas), diagnosis, types of causative agents (both allergens and irritants), and clinical management (systemic and topical therapies). Continuous measurements were reported as means with standard deviations (SD), while categorical variables were expressed as frequencies and percentages.

Data Processing and Analysis

Data collection and analysis were conducted using Excel program version 2024 (Microsoft Corporation) and statistically analysed with SPSS Version 25. The Health Research Ethics Committee of Dr. Soetomo General Academic Hospital Surabaya accepted this research under the number 1038/LOE/301.4.2/IX/2022.

Results

Sociodemographic Characteristics

Over a three-year period, the Dermatology and Venereology Outpatient Unit at Dr. Soetomo General Academic Hospital Surabaya attended to 32,226 patients, with 9,063 were over the age of 50. The incidence of elderly suffered from contact dermatitis in the outpatient unit from 2019 to 2021 was 0.99% (90 cases). Contact dermatitis in elderly occurred in 18.33% of all contact dermatitis patients (n=491). The age of the participants ranged from 50 to 90 years (mean 61.1 ± 7.9) and the largest proportion was female (67.8%), aged 55-65 years old. Majority of the participants work as housewives (42.2%) and office workers (30%) (**Table 1**).

Clinical Data

Based on **Table 2**, of the 90 participants, the initial symptoms observed among the CD patients were itch (93.3%), rash (72.2%), burning sensation

(24.4%), and hyperpigmentation (7.8%). Majority of the participants were newly diagnosed with the onset of CD less than a year (87.8%). The distribution of the body parts affected were the hands (36.7%) and face (24.4%), followed by lower limbs, upper limbs, feet, generalized and abdomen.

Table 1: Sociodemographic characteristics of the patients.

Sociodemographic characteristics	n (%)
Gender	
Female	61 (67.8)
Male	29 (32.2)
Age Range, Year	
50-54	23 (25.6)
55-65	44 (48.9)
66-74	17 (18.9)
75-90	6 (6.7)
Occupation	
Housewife	38 (42.2)
Office workers	27 (30)
Entrepreneur	4 (4.4)
Farmer	4 (4.4)
Teacher	1 (1.1)
Unemployed/retired	16 (17.8)

There were 90 elderly CD patients in this study, consisting of ACD (53.3%) and ICD (46.7%). In this study, the most common allergen were cosmetics (40.1%) and medicated oil (33.3%), followed by rubber sandal (9.9%), ointment (9.9%), and hair dye (6.7%) (**Figure 1**). **Figure 1** shows that herbal oil (25.9%), detergents (22.4%), and dishwashing soap (18.9%) are the irritative agents caused the most ICD.

Treatment

Cetirizine (71.1%), a second-generation antihistamine, was the most commonly prescribed sys-

temic treatment for the elderly. Followed by oral corticosteroids such as dexamethasone (22.2%) and methylprednisolone (2.2%). Antibiotics were administered to 5.5% of patients with secondary infections. The types of topical corticosteroids given were mometasone furoate (35.6%) and desoxymethasone (33.3%) being the most frequently used. A detailed overview of the therapies can be found in Table 3.

Table 2: Clinical characteristics and diagnosis of the study population.

Clinical characteristics	n (%)
Chief complaints*	
Itch	84 (93.3)
Rash	65 (72.2)
Burning sensation	22 (24.4)
Hyperpigmentation	7 (7.8)
Duration of the illness	
<1 year	79 (87.8)
1-2 years	8 (8.9)
3-4 years	3 (3.3)
Location*	
Hands	33 (36.7)
Face	22 (24.4)
Lower limbs	17 (18.9)
Upper limbs	15 (16.7)
Feet	15 (16.7)
Trunk	12 (13.3)
Generalized	6 (6.7)
Abdomen	4 (4.4)
Diagnosis of contact dermatitis	
Irritant contact dermatitis	48 (53.3)
Allergen contact dermatitis	42 (46.7)

*Note: Each patient may have one or more condition

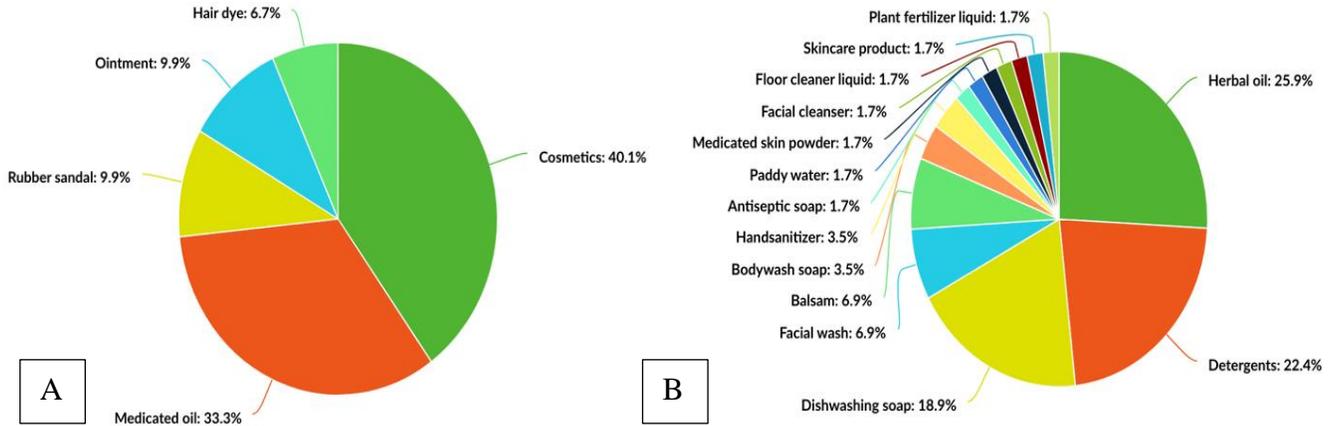


Figure 1: The distribution of causative agents in (A) allergic contact dermatitis (ACD) and (B) irritant contact dermatitis (ICD). Each patient may have one or more condition.

Table 3: Systemic and topical treatments for the contact dermatitis patients*

Treatment	n (%)
Systemic therapy	
<i>Antihistamine</i>	
Cetirizine	64 (71.1%)
Loratadine	8 (8.9%)
Chlorpheniramine maleat	1 (1.1%)
<i>Corticosteroids</i>	
Dexamethasone	20 (22.2%)
Methylprednisolone	2 (2.2%)
<i>Antibiotics</i>	
Erythromycin	3 (3.3%)
Amoxicillin	2 (2.2%)
Topical therapy	
<i>Corticosteroids</i>	
Mometasone Furoate	32 (35.6%)
Desoxymethasone	30 (33.3%)
Hydrocortisone	8 (8.9%)
<i>Antibiotic</i>	
Sodium fusidate cream	32 (35.6%)
<i>Moisturizer</i>	
Ceramide moisturizer	17 (18.9%)
Urea cream	9 (10%)
Glycerol cream	4 (4.4%)
Petroleum jelly	2 (2.2%)
<i>Others</i>	
Wet dressing with normal saline	6 (6.7%)

*Note: Each patient may have one or more treatment received

Discussion

Contact dermatitis (CD) is a prevalent global issue, caused by compromised skin barrier function and prolonged exposure to irritants and allergens. While it can occur at any age, CD is particularly common among adults.^{6,7} There is still a little evidence about the global epidemiology of CD in the elderly. The participants in this study ranged in age from 50 to 90 years (mean age 61.1 ± 7.9), with a significant majority being female (67.8%) in the 55-65 age group, followed by those aged 50-54. While other study conducted by Nemeth et al, in a total of 600 patients aged >60 years old, CD was the most common diagnosis accounting 63.7% of the cases. The largest age group in our study were 50-65 years old where the individuals still in their productive years which often remain actively engaged in the workforce and are capable of carrying out daily activities independently.⁸

The majority of patients in this study were female and mostly patients were housewives and office workers. A retrospective study conducted by Ginting et al, indicated that the most patients with CD were females, with 291 (79.3%) cases. Consistent with previous research, the prevalence of CD was found to be higher in females compared to males.⁹ The gender distribution in occupational allergic contact dermatitis might reflects differences in job roles, with women more frequently working in sectors like services and public administration, where exposure to allergens and irritants is common along with the habit of using cos-

metics and accessories.^{3,9,10}

The risk factors for CD are elevated in individuals with high mobility. The risk factor includes both work-related and personal elements, particularly in those with frequent occupational exposures. Contact dermatitis, especially hand dermatitis, frequently arises from an individual's work activities, hobbies, or habits, due to regular exposure to certain materials in daily life. Another contributing factor to the development of CD is the presence of dry skin, which is commonly observed in elderly. In the elderly, dry skin condition results from increased collagen degradation, increased transepidermal water loss, reduction in natural moisturizing factors, and alterations in skin structure associated with aging. This condition facilitates the entry of allergens or irritants into the skin and cause inflammatory reactions and irritation reactions on the skin.^{11,12,13}

Occupational hand dermatitis is a significant concern, with contact dermatitis being the primary cause. Both irritant contact dermatitis (ICD) and allergic contact dermatitis (ACD) are frequently observed in occupational environments, with irritant exposure identified as the predominant factor.^{14,15} This study reveals that the occupations most commonly affected by contact dermatitis among the elderly are housewives and workers. Similarly, other studies also found that housewives and office workers are the largest population who developed CD.¹⁰ Work activities often expose individuals to allergens and irritants. Housewives experienced CD as a result of exposure to allergens and irritants present in the home environment along with engagement in wet tasks. They frequently handle disinfectants, allergenic rubber, detergents, prolonged exposure to water, oils, and metal kitchen utensils. Housewives and cleaners typically had a frequent contact with soap, cleansers, dishwashing liquids which are the most common cause of ICD. In general, the leading causes of contact dermatitis in females are cosmetics and skincare products.⁹ From Ginting et al, study, shown that CD in general population are cosmetics (47.7%) and cleaning product (20%). Other study from Noviandini and Prakoeswa, reported that 18

of 27 patients (66.7%) presented positive results for a cosmetic patch test.^{9,14,15}

Our data shows that pruritus, rash, and burning sensation are the most frequent complaints in elder contact dermatitis. Work environment such as healthcare, where exposure to irritants is frequent ICD might occur due to frequent hand hygiene. Anamnesis and patch testing are very important in establishing the diagnosis of CD.^{16,17,18,19} Both types of CD presented as well-demarcated pruritic rash with redness and edema. Repeated exposures can lead to a chronic condition in which the lesions of CD may evolve into erythematous plaques, lichenification, and pigmentation changes, accompanied by accentuation of skin grooves.^{16,20}

The common predilection area for contact dermatitis in our study was hand, followed by face and extremities. According to European Surveillance System on Contact Allergies (ESSCA), hand and face had the highest prevalence in contact dermatitis since higher amount of exposure to these body regions due to daily activities especially the hands.²¹ This is because hands are the part of the body that is often exposed to allergens and irritants, due to individual daily activities. Repeated hand washing followed by drying hands can cause dry skin to the point of fissures, especially when the hand drying process is done quickly so that there is low ambient humidity.²¹ In addition, occupational contact dermatitis also occurs most often in the hand area, according to the material that comes into contact with the skin due to work or daily activities.^{16,17}

ACD reaction could be caused by metals, rubber, hair dye and temporary tattoos, chemical preservatives, fragrances, plant species, acrylates, and drugs (antibiotics, corticosteroids, local anaesthetics). In this study, the most common allergen were cosmetics and medicated oil, followed by rubber sandal, hair dye. For ICD, our study found that herbal oil, detergents, and dishwashing soap are the predominant irritative agents. A 40-year retrospective study in Taiwan reported nickel, cobalt, and medications in the early period however in year 2009 - 2018 the common allergens

were nickel, fragrance mix and cobalt.²² Cosmetics, cleanser, and topical medication were the most prevalent of suspected causative agents in study conducted by Widipriyatama et al.^{1,22,23} The topical herbal oil commonly used in Indonesian population were eucalyptus oil and wasp oil. Cosmetics components including active ingredients, preservatives, fragrances, emulsifiers, and vehicle components could cause allergic type CD. Several cases of using plant-derived medicated oil had reported hypersensitivity CD reactions due to its components of chemical ingredients and its concentration.^{23,24}

Identifying and eliminating the trigger is the primary management strategy for contact dermatitis. Patient education is essential to avoid the contact with allergens and irritative agents, using gloves in a wet work, and using a gentle skin care.^{2,19} Pharmacological therapy selection is typically determined by the clinical severity of CD. In this study, the most prescribed systemic therapy given was antihistamines followed by corticosteroids, while the main choice of topical therapy was corticosteroids. Contact dermatitis with localized acute flare ACD can be given topical corticosteroids as first-line therapy, which usually requires use for 2-3 weeks to prevent rebound. In cases of severe or widespread contact dermatitis, oral corticosteroids such as prednisone can be given and tapered as symptoms resolved. Topical corticosteroids in ICD can improve the condition of skin irritation by repairing the skin barrier and their anti-inflammatory effects, however prolonged use may result in epidermal thinning.^{16,17,19}

The regular use of emollients or moisturizer is highly recommended for restoring the skin barrier in all types of CD.¹⁶ Moisturizer ingredients such as occlusives (petrolatum, beeswax) can help prevent transepidermal water loss while humectants (urea, glycerin) can maintain the skin hydration.¹⁷ A prior clinical trial demonstrated the utilization of emollient containing antioxidants was found to be significantly improving the itchiness and redness in CD within one to seven days of application.²⁵ Due to this research's design was retrospective study, the clinical relevance of each factors with the incidence of contact dermatitis

could not be determined and some allergen sensitivities might not be detected.

Conclusion

Contact dermatitis (CD) in the elderly constitutes a notable dermatological concern, predominantly affecting females aged 55–65 years, with housewives and office workers representing the most vulnerable occupational groups. The hands and face were the most frequently involved sites, corresponding to their constant exposure to various allergens and irritants encountered in both domestic and occupational settings. Allergic contact dermatitis was most commonly induced by cosmetics and medicated oils, whereas irritant contact dermatitis was primarily associated with exposure to herbal oils, detergents, and dishwashing agents.

The results underscore the need for heightened awareness regarding skin barrier vulnerability in the elderly and the implementation of preventive measures aimed at minimizing contact with common sensitizers and irritants. Patient education on proper hand protection, avoidance strategies, and the routine use of moisturizers is essential in reducing recurrence and improving quality of life.

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Author's Contribution

D: Conception & design, acquisition of data, analysis & interpretation, drafting of article.

AAP: Conception & design, acquisition of data, analysis & interpretation, drafting of article, final approval of the version to be published.

RA: Conception & design, drafting of article, revising it critically.

SA: Conception & design, drafting of article, revising it critically.

FTK: Conception & design, drafting of article, Analysis & interpretation of data.

SFW: Conception & design, acquisition of data, analysis & interpretation of data, drafting of article, revising it critically, final approval of the version to be published.

References

1. Brar KK. A review of contact dermatitis. *Ann Allergy Asthma Immunol.* 2021;126(1):32-39. Doi: 10.1016/j.anai.2020.10.003.
2. Li Y, Li L. Contact Dermatitis: Classifications and Management. *Clin Rev Allergy Immunol.* 2021;61(3):245-281. Doi: 10.1007/s12016-021-08875-0.
3. Németh D, Pónyai G. Contact Allergy in the Elderly: A Study of 600 Patients. *Life (Basel).* 2022;12(8):1228. Doi: 10.3390/life12081228.
4. Damayanti. Pruritus in elderly: classification and management. *World Journal of Advanced Research and Reviews.* 2024;21(1):254-9.
5. Mazan P, Lesiak A, Narbutt J. Pruritus in elderly patients: review of literature. *Forum Dermatologicum.* 2024; 10(1):1-9.
6. Proksch E, Brasch J. Role of the Permeability Barrier in Contact Dermatitis. In: Johansen, J.D., Mahler, V., Lepoittevin, JP., Frosch, P.J. (eds) *Contact Dermatitis.* Springer, Cham. 2021.
7. Yu J, Johnson H, DeKoven JG, Warshaw EM, Taylor JS, Belsito DV, et al. Patch Test Results Among Older Adults: A Retrospective Analysis of the North American Contact Dermatitis® Group Data (2009-2020). *Dermatitis.* 2024;35(3):235-241. Doi: 10.1089/derm.2023.0130.
8. Yıldız E, Çölkesen F, Arslan Ş, Evcen R, Aykan FS, Kılınç M, et al. Allergic diseases in the elderly population: a single-center experience. *Turk J Med Sci.* 2021;51(5):2631-2640. Doi: 10.3906/sag-2104-55.
9. Ginting E, Damayanti D, Fetarayani D, Hidayati AN. Contact Dermatitis in Tertiary Hospital: A 2-year Retrospective Study. *Berk Ilmu Kesehatan Kulit Kelamin.* 2021;33(2):88-92.
10. Salvati, L., Vanni, E., Acciai, M.C. et al. A gender-specific approach to occupational allergic contact dermatitis. *Allergo J Int.* 2021;30:109-14.
11. Schütte MG, Tamminga SJ, de Groene GJ, Kezic S, van der Molen HF. Work-related and personal risk factors for occupational contact dermatitis: A systematic review of the literature with meta-analysis. *Contact Dermatitis.* 2023;88(3):171-187. Doi: 10.1111/cod.14253..
12. Damayanti, Putri NS, Triesayuningtyas DC, Firdausi H, Astindari, Indranarum T, et al. The Correlation between Comorbid Factors and Xerosis Cutis in Elderly. *J Pak Assoc Dermatol.* 2023;33(2):507-12.
13. Kitagaki H. Skin Health of the Elderly and People in Long-term Care. *Current Cosmetic Science.* 2023; 2:e200323214765.
14. Karagounis TK, Cohen DE. Occupational Hand Dermatitis. *Curr Allergy Asthma Rep.* 2023;23(4):201-212. Doi: 10.1007/s11882-023-01070-5.
15. Damayanti, Astindari, Indranarum T, Hadiwidjaja FN, Axelia PG, Mappamasing H. Knowledge Improvement of Xerosis Cutis through Health Education in the Elderly. *Berk Ilmu Kesehatan Kulit Kelamin.* 2022; 34(3): 174-7.
16. Turrentine JEE, Sheehan MP, Cruz PD. Allergic Contact Dermatitis. In: Fitzpatrick's Dermatology. New York: McGraw-Hill Education. 2019. Pp.395-413.
17. Nedorost ST. Irritant Dermatitis. In: Fitzpatrick's Dermatology. New York: McGraw-Hill Education. 2019. pp.414-427
18. Japundžić I, Novak-Hlebar I, Špiljak B, Kuna M, Yale K, Lugović-Mihić L. Skin Features Important for the Occurrence of Contact Dermatitis in Healthcare Workers. *Acta Clin Croat.* 2022;61(4):692-702. Doi: 10.20471/acc.2022.61.04.16.
19. Patel K, Nixon R. Irritant Contact Dermatitis - a Review. *Curr Dermatol Rep.* 2022;11(2):41-51. doi: 10.1007/s13671-021-00351-4
20. Tramontana M, Hansel K, Bianchi L, Sensini C, Malatesta N, Stingeni L. Advancing the understanding of allergic contact dermatitis: from pathophysiology to novel therapeutic approaches. *Front Med (Lausanne).* 2023;10:1184289. Doi: 10.3389/fmed.2023.1184289. .
21. Loman L, Uter W, Armario-Hita JC, Ayala F, Balato A, Ballmer-Weber BK, et al; ES-SCA Working Group. European Surveillance System on Contact Allergies (ESSCA): Characteristics of patient's patch tested and diagnosed with irritant contact dermatitis. *Contact Dermatitis.* 2021; 85(2): 186-97.
22. Lin PH, Tseng YH, Chu CY. Changing trends of contact allergens: A 40-year retrospective study from a referral centre in northern Taiwan. *Contact Dermatitis.* 2021;85(1):39-45. Doi: 10.1111/cod.13795.
23. WidiPriyatama GR, Damayanti, Dewanti L, Anggraeni S. Clinical Profile of Contact Dermatitis Patients at the Allergy-Immunology Division of Dermatology and Venereology Outpatient Clinic. *Berk Ilmu Kesehatan Kulit Kelamin.* 2023;35(2): 100-106.
24. Atwater AR, Petty AJ, Liu B, Green CL, Silverberg JI, DeKoven JG, et al. Contact dermatitis associated with preservatives: Retrospective analysis of North American Contact Dermatitis Group data, 1994

- through 2016. *J Am Acad Dermatol.* 2021;84(4):965-976. Doi: 10.1016/j.jaad.2020.07.059.
25. Dickel H, Bauer A, Brehler R, Mahler V, Merk HF, Neustädter I, et al. German S1 guideline: Contact dermatitis. *J Dtsch Dermatol Ges.* 2022;20(5):712-734. Doi: 10.1111/ddg.14734.